What is a Sensor? Different Types of Sensors and their Applications

April 2, 2021 By Ravi Teja

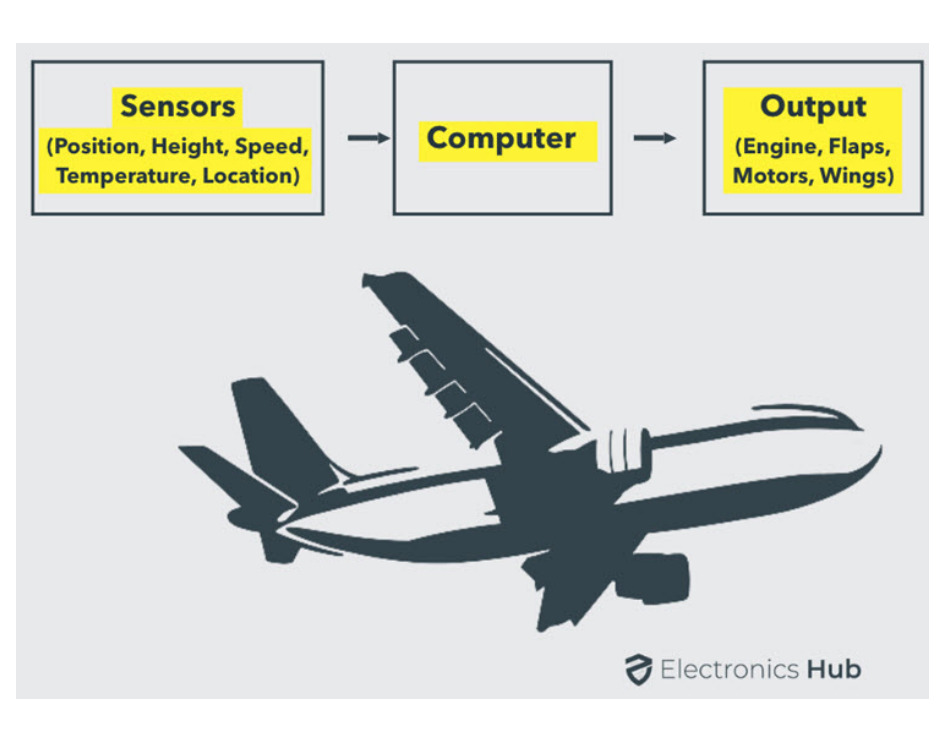
We live in a World of Sensors. You can find different types of Sensors in our homes, offices, cars etc. working to make our lives easier by turning on the lights by detecting our presence, adjusting the room temperature, detect smoke or fire, make us delicious coffee, open garage doors as soon as our car is near the door and many other tasks.

All these and many other automation tasks are possible because of Sensors. Before going in to the details of What is a Sensor, What are the Different Types of Sensors and Applications of these different types of Sensors, we will first take a look at a simple example of an automated system, which is possible because of Sensors (and many other components as well).

Outline

Real Time Application of Sensors

The example we are talking about here is the Autopilot System in aircrafts. Almost all civilian and military aircrafts have the feature of Automatic Flight Control system or sometimes called as Autopilot.


Sensors
(Position, Height, Speed, Temperature, Location)
Computer
Output
(Engine, Flaps, Motors, Wings)
Electronics Hub

An Automatic Flight Control System consists of several sensors for various tasks like speed control, height monitoring, position tracking, status of doors, obstacle detection, fuel level, maneuvering and many more. A Computer takes data from all these sensors and processes them by comparing them with pre-designed values.

The computer then provides control signals to different parts like engines, flaps, rudders, motors etc. that help in a smooth flight. The combination of Sensors, Computers and Mechanics makes it possible to run the plane in Autopilot Mode.

All the parameters i.e., the Sensors (which give inputs to the Computers), the Computers (the brains of the system) and the mechanics (the outputs of the system like engines and motors) are equally important in building a successful automated system.

This is an extremely simplified version of Flight Control System. In fact, there are hundreds of individual control systems which preform unique tasks for a safe and smooth journey.

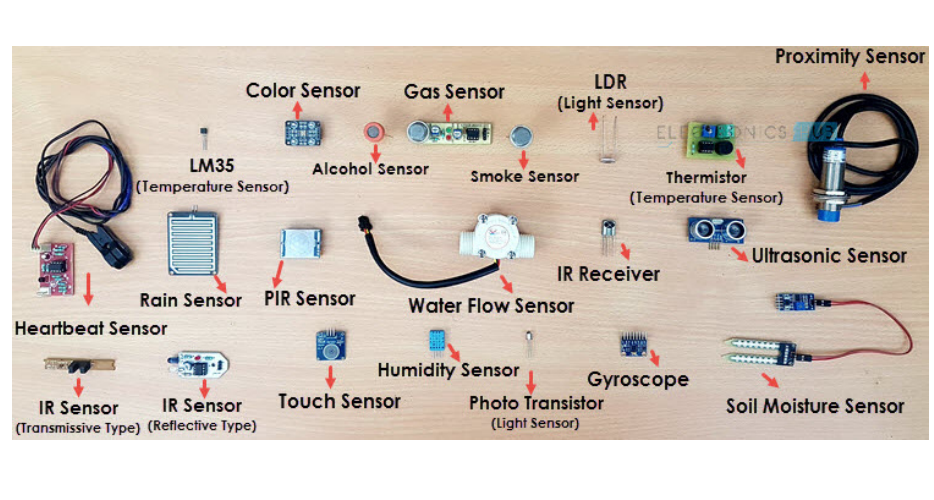
But in this tutorial, we will be concentrating on the Sensors part of a system and look at different concepts associated with Sensors (like types, characteristics, classification etc.).

What is a Sensor?

There are numerous definitions as to what a sensor is but I would like to define a Sensor as an input device which provides an output (signal) with respect to a specific physical quantity (input).

The term "input device" in the definition of a Sensor means that it is part of a bigger system which provides input to a main control system (like a Processor or a Microcontroller).

Another unique definition of a Sensor is as follows: It is a device that converts signals from one energy domain to electrical domain. The definition of the Sensor can be better understood if we take an example in to consideration.



The simplest example of a sensor is an LDR or a Light Dependent Resistor. It is a device, whose resistance varies according to intensity of light it is subjected to. When the light falling on an LDR is more, its resistance becomes very less and when the light is less, well, the resistance of the LDR becomes very high.

We can connect this LDR in a voltage divider (along with other resistor) and check the voltage drop across the LDR. This voltage can be calibrated to the amount of light falling on the LDR. Hence, a Light Sensor.

Now that we have seen what a sensor is, we will proceed further with the classification of Sensors.

Classification of Sensors

There are several classifications of sensors made by different authors and experts. Some are very simple and some are very complex. The following classification of sensors may already be used by an expert in the subject but this is a very simple classification of sensors.

In the first classification of the sensors, they are divided in to Active and Passive. Active Sensors are those which require an external excitation signal or a power signal.

Passive Sensors, on the other hand, do not require any external power signal and directly generates output response.

The other type of classification is based on the means of detection used in the sensor. Some of the means of detection are Electric, Biological, Chemical, Radioactive etc.

The next classification is based on conversion phenomenon i.e., the input and the output. Some of the common conversion phenomena are Photoelectric, Thermoelectric, Electrochemical, Electromagnetic, Thermooptic, etc.

The final classification of the sensors are Analog and Digital Sensors. Analog Sensors produce an analog output i.e., a continuous output signal (usually voltage but sometimes other quantities like Resistance etc.) with respect to the quantity being measured.

Digital Sensors, in contrast to Analog Sensors, work with discrete or digital data. The data in digital sensors, which is used for conversion and transmission, is digital in nature.

Different Types of Sensors

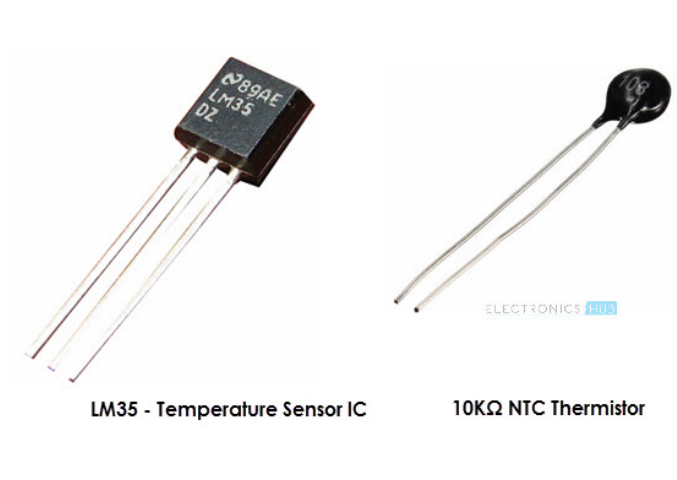
The following is a list of different types of sensors that are commonly used in various applications. All these sensors are used for measuring one of the physical properties like Temperature, Resistance, Capacitance, Conduction, Heat Transfer etc.

1. Temperature Sensor
2. Proximity Sensor
3. Accelerometer
4. IR Sensor (Infrared Sensor)
5. Pressure Sensor
6. Light Sensor
7. Ultrasonic Sensor
8. Smoke, Gas and Alcohol Sensor
9. Touch Sensor
10. Color Sensor
11. Humidity Sensor
12. Position Sensor
13. Magnetic Sensor (Hall Effect Sensor)
14. Microphone (Sound Sensor)
15. Tilt Sensor
16. Flow and Level Sensor
17. PIR Sensor
18. Touch Sensor
19. Strain and Weight Sensor

We will see about few of the above-mentioned sensors in brief. More information about the sensors will be added subsequently. A list of projects using the above sensors is given at the end of the page.

Temperature Sensor

One of the most common and most popular sensors is the Temperature Sensor. A Temperature Sensor, as the name suggests, senses the temperature i.e., it measures the changes in the temperature.



There are different types of Temperature Sensors like Temperature Sensor ICs (like LM35, DS18B20), Thermistors, Thermocouples, RTD (Resistive Temperature Devices), etc.

Temperature Sensors can be analog or digital. In an Analog Temperature Sensor, the changes in the Temperature correspond to change in its physical property like resistance or voltage. LM35 is a classic Analog Temperature Sensor.

Coming to the Digital Temperature Sensor, the output is a discrete digital value (usually, some numerical data after converting analog value to digital value). DS18B20 is a simple Digital Temperature Sensor.

Temperature Sensors are used everywhere like computers, mobile phones, automobiles, air conditioning systems, industries etc.

A simple project using LM35 (Celsius Scale Temperature Sensor) is implemented in this project: TEMPERATURE CONTROLLED SYSTEM.

Proximity Sensors

A Proximity Sensor is a non-contact type sensor that detects the presence of an object. Proximity Sensors can be implemented using different techniques like Optical (like Infrared or Laser), Sound (Ultrasonic), Magnetic (Hall Effect), Capacitive, etc.

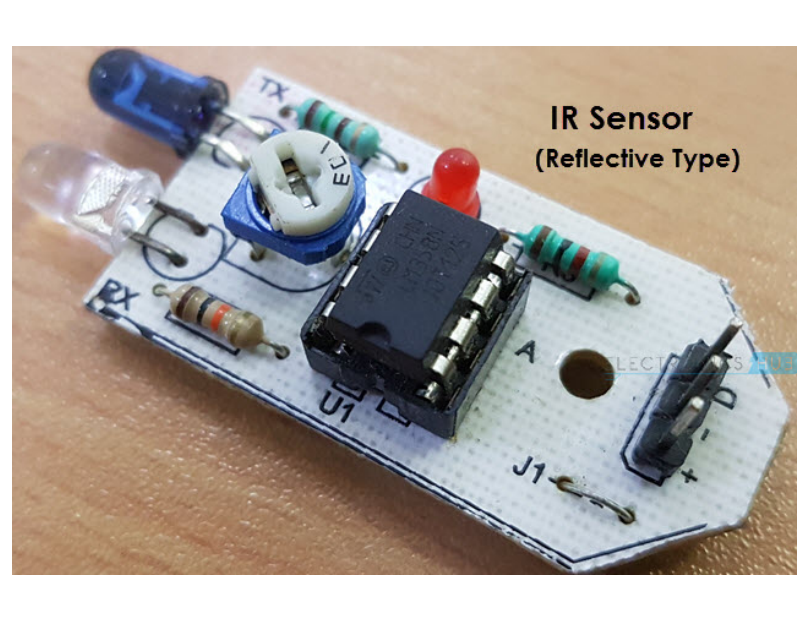
Inductive Proximity Sensor

Some of the applications of Proximity Sensors are Mobile Phones, Cars (Parking Sensors), industries (object alignment), Ground Proximity in Aircrafts, etc.

Proximity Sensor in Reverse Parking is implemented in this Project: REVERSE PARKING SENSOR CIRCUIT.

Infrared Sensor (IR Sensor)

IR Sensors or Infrared Sensor are light based sensor that are used in various applications like Proximity and Object Detection. IR Sensors are used as proximity sensors in almost all mobile phones.



There are two types of Infrared or IR Sensors: Transmissive Type and Reflective Type. In Transmissive Type IR Sensor, the IR Transmitter (usually an IR LED) and the IR Detector (usually a Photo Diode) are positioned facing each other so that when an object passes between them, the sensor detects the object.

The other type of IR Sensor is a Reflective Type IR Sensor. In this, the transmitter and the detector are positioned adjacent to each other facing the object. When an object comes in front of the sensor, the infrared light from the IR Transmitter is reflected from the object and is detected by the IR Receiver and thus the sensor detects the object.

Different applications where IR Sensor is implemented are Mobile Phones, Robots, Industrial assembly, automobiles etc.

A small project, where IR Sensors are used to turn on street lights: STREET LIGHTS USING IR SENSORS.

Ultrasonic Sensor

An Ultrasonic Sensor is a non-contact type device that can be used to measure distance as well as velocity of an object. An Ultrasonic Sensor works based on the properties of the sound waves with frequency greater than that of the human audible range.

HC-SR04
Ultrasonic Sensor

Using the time of flight of the sound wave, an Ultrasonic Sensor can measure the distance of the object (similar to SONAR). The Doppler Shift property of the sound wave is used to measure the velocity of an object.

Arduino based Range Finder is a simple project using Ultrasonic Sensor: PORTABLE ULTRASONIC RANGE METER.

Light Sensor

Sometimes also known as Photo Sensors, Light Sensors are one of the important sensors. A simple Light Sensor available today is the Light Dependent Resistor or LDR. The property of LDR is that its resistance is inversely proportional to the intensity of the ambient light i.e., when the intensity of light increases, its resistance decreases and vise-versa.

By using LDR is a circuit, we can calibrate the changes in its resistance to measure the intensity of Light. There are two other Light Sensors (or Photo Sensors) which are often used in complex electronic system design. They are Photo Diode and Photo Transistor. All these are Analog Sensors.

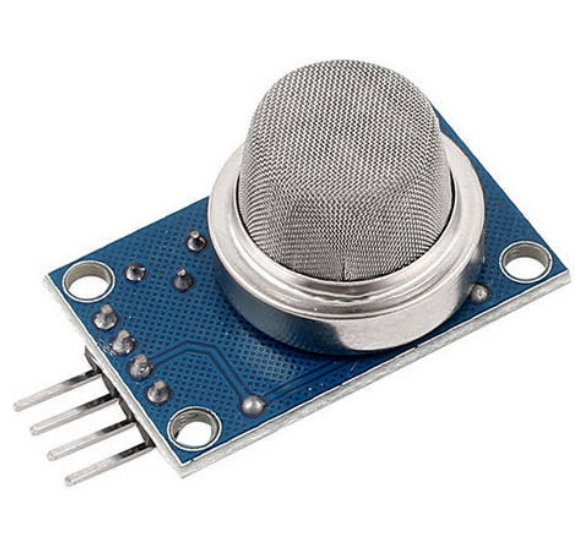
There are also Digital Light Sensors like BH1750, TSL2561, etc., which can calculate intensity of light and provide a digital equivalent value.

Check out this simple LIGHT DETECTOR USING LDR project.

Smoke and Gas Sensors

One of the very useful sensors in safety related applications are Smoke and Gas Sensors. Almost all offices and industries are equipped with several smoke detectors, which detect any smoke (due to fire) and sound an alarm.

Gas Sensors are more common in laboratories, large scale kitchens and industries. They can detect different gases like LPG, Propane, Butane, Methane (CH4), etc.



Now-a-days, smoke sensors (which often can detect smoke as well gas) are also installed in most homes as a safety measure.

The "MQ" series of sensors are a bunch of cheap sensors for detecting CO, CO2, CH4, Alcohol, Propane, Butane, LPG etc. You can use these sensors to build your own Smoke Sensor Application.

Check out this SMOKE DETECTOR ALARM CIRCUIT without using Arduino.

Alcohol Sensor

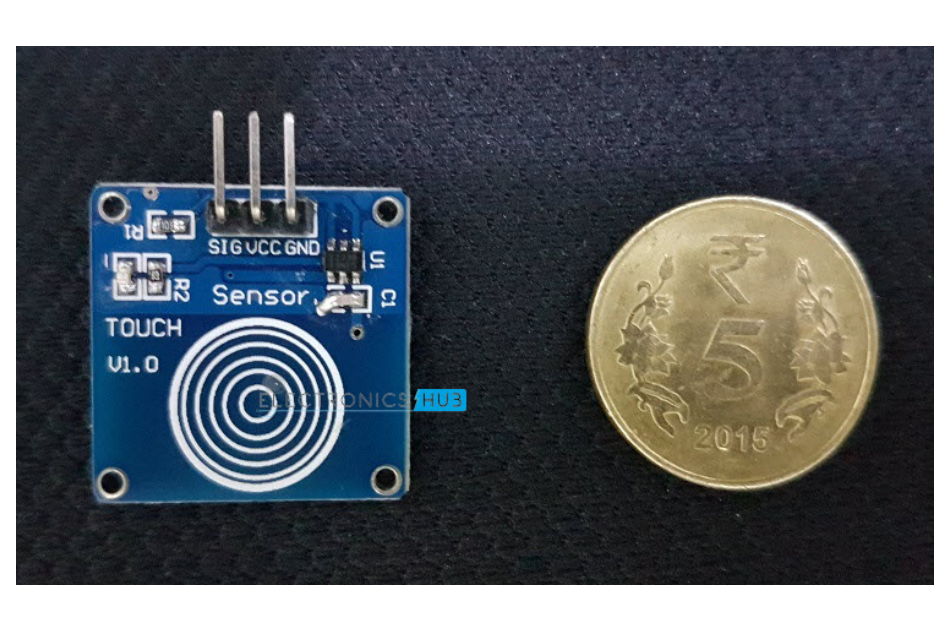
As the name suggests, an Alcohol Sensor detects alcohol. Usually, alcohol sensors are used in breathalyzer devices, which determine whether a person is drunk or not. Law enforcement personnel uses breathalyzers to catch drunk-and-drive culprits.

A simple tutorial on HOW TO MAKE ALCOHOL BREATHALYZER CIRCUIT?

Touch Sensor

We do not give much importance to touch sensors but they became an integral part of our life. Whether you know or not, all touch screen devices (Mobile Phones, Tablets, Laptops, etc.) have touch sensors in them. Another common application of touch sensor is trackpads in our laptops.

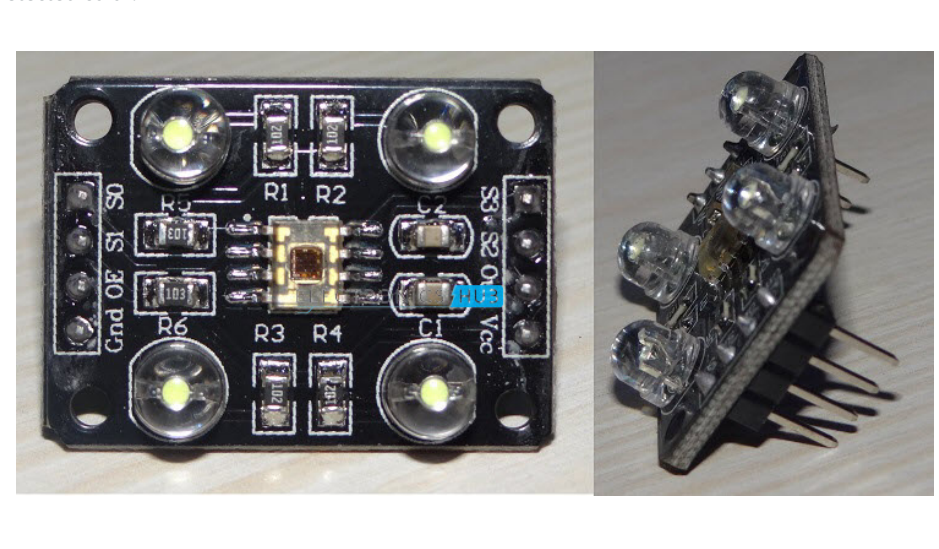
Touch Sensors, as the name suggests, detect touch of a finger or a stylus. Often touch sensors are classified into Resistive and Capacitive type. Almost all modern touch sensors are of Capacitive Types as they are more accurate and have better signal to noise ratio.



If you want to build an application with Touch Sensor, then there are low-cost modules available and using those touch sensors, you can build TOUCH DIMMER SWITCH CIRCUIT USING ARDUINO.

Color Sensor

A Color Sensor is an useful device in building color sensing applications in the field of image processing, color identification, industrial object tracking etc. The TCS3200 is a simple Color Sensor, which can detect any color and output a square wave proportional to the wavelength of the detected color.

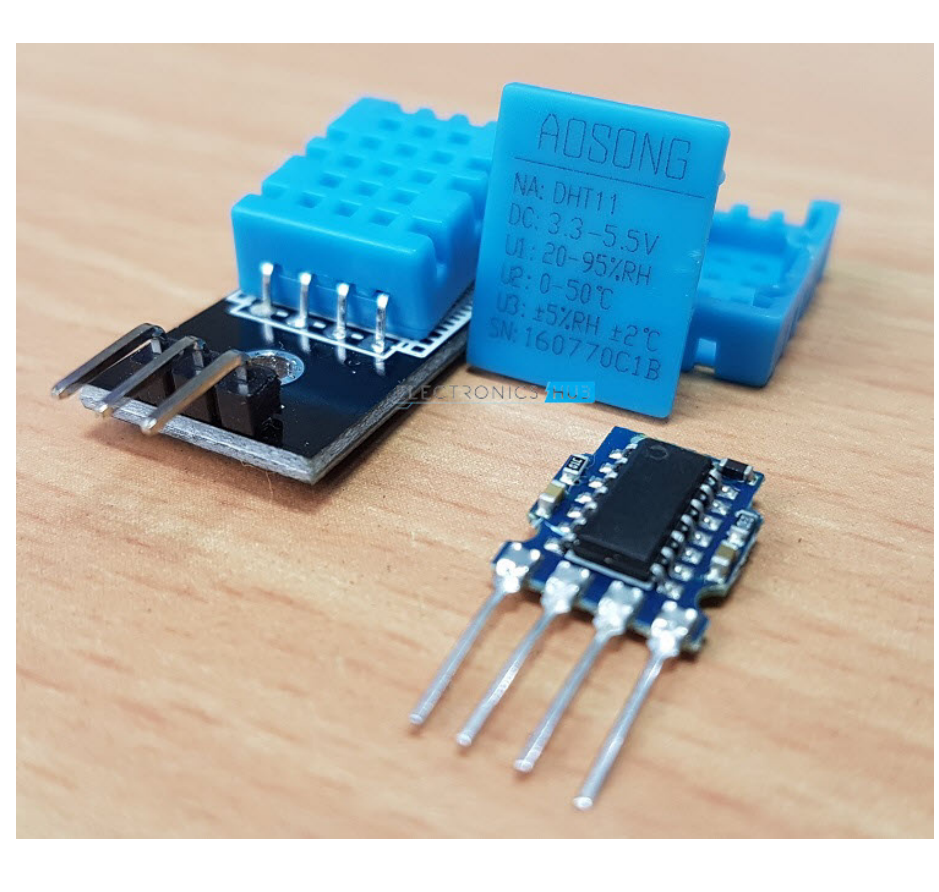


If you are interested in building a Color Sensor Application, checkout this ARDUINO BASED COLOR DETECTOR project.

Humidity Sensor

If you see Weather Monitoring Systems, they often provide temperature as well as humidity data. So, measuring humidity is an important task in many applications and Humidity Sensors help us in achieving this.

Often all humidity sensors measure relative humidity (a ratio of water content in air to maximum potential of air to hold water). Since relative humidity is dependent on temperature of air, almost all Humidity Sensors can also measure Temperature.

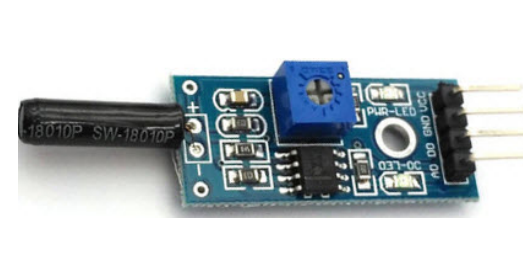


Humidity Sensors are classified into Capacitive Type, Resistive Type and Thermal Conductive Type. DHT11 and DHT22 are two of the frequently used Humidity Sensors in DIY Community (the former is a resistive type while the latter is capacitive type).

Checkout this tutorial with DHT11 HUMIDITY SENSOR ON ARDUINO.

Tilt Sensor

Often used to detect inclination or orientation, Tilt Sensors are one of the simplest and inexpensive sensors out there. Previously, tilt sensors are made up of Mercury (and hence they are sometimes called as Mercury Switches) but most modern tilt sensors contain a roller ball.



A simple Arduino based title switch using tilt sensor is implemented here HOW TO MAKE A TILT SENSOR WITH ARDUINO?

In this article, we have seen about What is a Sensor, what are the classification of sensors and Different Types of Sensors along with their practical applications. In the future, I will update this article with more sensors and their applications.

Related Posts:

- Why Solar Lights not Working - Common Reasons
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- Automatic Room Lights using Arduino and PIR Sensor
- The 7 Best Z Wave Door Sensor Reviews in 2023
- 22 Different Types of Light Switches

51 Responses

Ravi Kacha says: December 16, 2017 at 1:57 am

Very interesting spacial for tilt sensor

One questions what function of tilt sensor in solar tiltsensor type tracker

Reply

Dariush Mohazzabi says: December 21, 2017 at 12:21 am

Excellent. Brief but comprehensive.
Better pointers for details of design and access for ordering would be helpful.

Reply

Kalpesh D. Wani says: December 21, 2017 at 12:08 pm

Short simple informative.

Reply

jhon mark lagua says: January 31, 2018 at 11:38 pm

thanks for this blog gives me such wonderful ideas how the circuits really works

Reply

Bhushan patil says: February 23, 2018 at 10:37 am

It is a very impotent information for learning about sensor

Reply

Shriram says: February 28, 2018 at 9:40 pm

Can we built a sensor for our requirements ?!!

Reply

aditya rav bouddh says: June 12, 2018 at 11:55 am

yes we built a sensor as requirement.we should know about principle of physics that how does working

Reply

Sun Prince Singh says: March 13, 2018 at 12:09 pm

What is made the material of sensors
What is the good quality of sensor

Reply

master says: October 15, 2018 at 4:35 am

English very best

Reply

Thiyagarajan says: April 4, 2018 at 12:38 pm

Is there invisible sensors?

Reply

sravya says: April 8, 2018 at 1:54 am

Could you help me to make a smart stick for blind people by voice message

Reply

aditya rav bouddh says: June 12, 2018 at 12:14 pm

it is build by arduino..and make programm by coding.

Reply

Waliu says: May 26, 2021 at 7:25 am

You mean the stick will be program by arduino?!! Also can Python be use for the coding?

Reply

Asongwe nji thierry says: April 14, 2018 at 4:49 am

I like this if posible u can sent in my email,thanks very much for understanding

Reply

JOHN MULINDI says: April 28, 2018 at 5:26 am

Good article, but maybe you could have provided more examples in the post.

Reply

Ravi says: May 1, 2018 at 12:58 am

Thanks John.
I will try to update the post with more sensors and examples.

Reply

Mohmd Nawas says: December 30, 2021 at 3:46 am

Can you please tell me. Which type of sensor using airport buggage conveyor belt

Reply

Stephen says: May 9, 2018 at 10:58 am

Very educative.

Reply

Je says: May 13, 2018 at 4:23 am

There is another movement sensor which wors on microwaves. It ischeap and penetrates woods, plastic but not metal. It detects only humans , animals body not all objects like ir. It can be found as radar sensor but is not radar even it works on microwaves.

Reply

prabakaran says: May 13, 2018 at 11:12 am

I like this .this is useful for school and college students

Reply

Kalyan says: May 30, 2018 at 11:26 am

Very interesting…

Reply

aditya rav bouddh says: June 12, 2018 at 12:05 pm

good informetion..thanks.

Reply

Smrithi says: July 19, 2018 at 11:26 am

Was very helpful for my home work
Thank you so much Ravi sir thank you

Reply

Kate Namwinga says: July 19, 2018 at 4:59 pm

can paper sensors be found?

Reply

Dhanush M M says: July 25, 2018 at 6:54 am

It was very useful & informative.

Reply

Jino says: July 25, 2018 at 10:30 am

Used information

Reply

sundarabi says: July 26, 2018 at 5:31 am

super bro the she well all people

Reply

A RAMMOHAN REDDY says: July 26, 2018 at 10:36 am

Very informative blog. My request is in the next blog please mention about good quality sensors in the market and how to get them. I am interested to provide them to some students in govt. schools so as to make the students experiment and learn the subject.
It is very exciting.

Reply

Stella.T says: July 30, 2018 at 6:03 am

Really helped me to complete my homework…

Reply

Carlos Llan says: August 2, 2018 at 12:36 am

Sitio con muy buenas propuestas para todos los amantes de electrónica, gracias por vuestros aportes.
Saludos mil

Reply

Peter christian says: August 13, 2018 at 5:08 am

Please how does actuator manage the environment in motor car?

Reply

Ggaayi Abraham says: October 10, 2018 at 11:21 am

Trying to build a network of sensors for mechanical systems of a vehicle, using sensors. This is good but I need more clarification on sensors that work on rubber!

Reply

Charles warren says: October 13, 2018 at 3:13 am

What kind of sensor can count the number of movement? Example squats.

Reply

best says: October 30, 2018 at 3:23 am

thanks for your humble efforts .

Reply

Aathif Afsal says: October 30, 2018 at 10:21 pm

Thank you for this article.T'was very useful

Reply

Cher says: May 4, 2019 at 10:23 am

I'm researching to see if there is some type of object sensor available small enough to put on a dog collar that could help a blind pet. Any ideas would be appreciated.

Reply

Simon Pech Dau says: May 8, 2019 at 4:24 am

Thank you for your effort,it is a basic information to engineering students.

Reply

Atteh says: October 7, 2019 at 9:37 am

Very brief, interesting and educative. We need more on practical aspects .I also need it in my email.

Reply

Gerata raju says: December 7, 2019 at 9:49 pm

Yes It's very excited to read
Thanks for you

Reply

Howie Mutorera says: November 17, 2020 at 12:38 pm

Very handy, I've enjoyed every piece of this. Thank you in earnest.

Reply

pavan says: March 17, 2021 at 3:04 am

Nice article about sensors. THanks a lot

Reply

all tech says: March 17, 2021 at 3:04 am

Nice article about sensors. Thanks a lot

Reply

Waliu says: May 26, 2021 at 7:28 am

Thanks I gain from the article.

Reply

adebabay mihret says: April 8, 2021 at 12:44 am

it has a good idea for electrical engineering

Reply

Breton Tom says: June 17, 2021 at 9:33 pm

It's a very good Article. As some one mentioned, it's brief, but very informative. I'm tagging it for inclusion in my 'POCKET' Library. Saw Article in a PINTEREST E?MAIL.

Reply

Peter Mburu says: July 6, 2021 at 12:40 am

Very educative article

Reply

Tommy J says: July 16, 2021 at 3:43 pm

Nice article, very infomative.

Reply

Boluwatife Ogunyemi says: March 12, 2022 at 6:47 pm

Thank you very much!
Was really helpful.

Reply

Spider - Aarudh says: April 13, 2022 at 6:14 am

Thank you very much!
Was really helpful.

Reply

Gayuni Nadinsa says: August 27, 2022 at 3:27 am

Easy to understand…Thank you very much

Reply

Nikhil says: March 15, 2023 at 11:54 pm

Thank you for sharing this knowledge with us. Very informative for technical student for learning.

Reply

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